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Abstract

Measurement of High-dose Gamma Fluxes at Reactor Pulses and Strong Gamma Sources by the Conductivity of Cuprous Oxide

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Cuprous oxide with a coarse crystalline structure was produced from copper plates (1 x 20 x 80 mm) by a special oxidation process. The specific electric conductivity of this material is not different from that of single crystals. In the case of fine crystalline specimens, the conductivity increases proportionately with the number of crystals per unit area. This behaviour is the result of higher concentration of crystal defects on the grain surfaces.

Under the influence of gamma and X-ray irridiation the conductivity is increased. The lower the initial conductivity of the material, the greater is the relative effect. The results thus obtained showed a linear dependence and proved coarse crystalline Cu_2O to be most suitable for high gamma flux determinations.

Immediately after the commencement of irridiation by a strong gamma source, a sharp decrease of the Cu_2O resistance is measured; after a few minutes the curve becomes less steep and turns into a linear section. When irradiation is interrupted, the first decrease recombines almost completely in a very short time, while the annealing of the defects characterized through the linear section of the curve, takes place very slowly and is therefore a long-term effect.

Reversible conductivity changes in the Cu_2O specimens were in fact obtained by short gamma pulses at the reactor (TRIGA Mark II).

Due to the inherent safety of the reactor, power pulses of up to 300 MW can be obtained. The half-width of the pulse is approximately 30 msec. The Cu_2O specimens were covered with cadmium and placed in positions where gamma dose-rates of several kr/h (30 - 70 r/pulse duration) were obtainable. The curve of the conductivity measured during the pulse is almost identical with that of the reactor power. It is possible with this comparatively simple Cu_2O conductivity measurement device, to measure the peak power of the reactor pulse and to transfer electronically the data obtained. As far as a reactor pulse can be taken for a simulation of a power excursion in a nuclear fuel plant, the above method of measuring the Cu_2O conductivity can be used as a monitoring system for nuclear power accidents.

Furthermore Cu_2O specimens can be used to measure high doses gamma fluxes from continuously radiating sources by putting the sample for a certain time in the place in question and subsequently measuring the conductivity. The mechanism of the conductivity and the influence of the radiation on the crystal defects is briefly discussed.